

## Basic Materials

*The Basic Materials category outlines technology in coatings, chemicals, or ingredients that improve durability and longevity; composite materials; advanced multipurpose materials; and structural or strength materials. These technologies, many of which originated at basic research levels in universities or national labs, hold promise for a variety of construction applications.*

### Technology Scanning

One of PATH's major research support services is PATH Technology Scanning. *Technology Scanning* tells us about technology developments in other industries, from other nations, from federal laboratories, and from other building sectors. PATH looks for breakthroughs in other industries that could be transferred and applied to housing. *Technology Scanning*—published by the U.S. Department of Housing and Urban Development/PATH and prepared by the NAHB Research Center—is updated as technology developments dictate. The Research Center works to unite technology developers from outside of residential construction with manufacturers in the residential housing sector.

This issue of *Technology Scanning* is one in a series. Each issue in the series falls into one of the following categories:

- Design and Internet Tools
- Safety
- Surfaces and Interior Finishes
- Building Envelope Technologies
- Electrical
- Plumbing
- Heating, Ventilating and Air Conditioning
- Energy/Power Systems Generation
- Basic Materials
- Information Technology
- Sustainable Design Strategies
- Materials Recycling and Reuse
- Thermal and Moisture Protection
- Indoor Environmental Quality

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## Composite/Fiber Structural Materials & Applications

### Portable Roadway & Damage-Free Access Systems

Lightweight, super-strength panels made from engineered composites form a new product called MUD-TRAKS. These mats or panels can be used as temporary roadways to prevent damage to the surrounding area during construction. Applications can include crossing lawns with heavy equipment without damage, temporary parking areas without tearing up soil or grassy areas, wetland area access without creating and repairing huge ruts. These space-age materials allow the panel to bend and flex under extreme loads from backhoes to 100,000-lb. cranes. MUD-TRAKS are textured top and bottom for traction and ground gripping. They don't absorb water or rot like plywood left down for extended periods of time. They are not affected by heat or cold. They don't crack or break like plywood. They can also be used as jack pads for heavy equipment.

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### New Design Guide for FRP Rebar

The rapidly emerging use of fiber reinforced pultrusion as rebar material for concrete applications has brought forth a new design guide for FRP rebar from the American Concrete Institute.

*The Guide for the Design and Construction of Concrete Reinforced with FRP Bars* gives recommendations and procedures for the design and use of non pre-stressed FRP reinforced structures. The document gives assistance to engineers and building officials while supplementing codes and other guidelines for use of FRP in concrete.

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Courtesy: SVE Sales

**450,000 pound house moving across a corn field.**

### Polymer Rebar Extends the Life of Concrete Structures

Carol Shield, an associate professor in Civil Engineering at the University of Minnesota's Institute of Technology, has developed a replacement for traditional steel rebar used in roadways. Minnesota winters and use of de-icing salt and chemicals is tough on roadways and concrete rebar. Her research, funded by the Minnesota Department of Transportation, could have applications in any concrete application in search of a more durable, cost-effective, easier to work with alternative to steel rebar. The nonconductor polymer rebar resists fatigue and corrosion better than standard steel. Tests in Minnesota bridges have shown the material to respond to thermal and mechanical stress better. Researchers are 90 percent through the concept developments. Further testing of applications in civil, commercial, and residential construction will prove it out beyond roadways.

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### **Underground, One-Piece Fiber Glass Ultimate Storm Shelter**

Southern Illinois Storm Shelters, Inc. recently introduced a one-piece, self-contained unit that provides shelter during severe weather, tornados, and hurricanes. The standard unit is 6'6" W x 8'6" L with headroom of 6'3". The unit, molded of fiberglass composites, is buried in the ground much like a fuel tank. It has a surface access sealed door system with folding steps and six-point locking, molded-in seating, carpeting, handrail and 12 cubic feet of molded-in storage space for emergency supplies. The shelters hold eight to ten adults and exceed FEMA 320 standards. The unit has a screened cross-ventilation system. It ships easily by truck or trailer and pickup truck. They are working on a larger unit for 20 people as well.

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### **New Wood Composites Technology**

The University of Maine received a patent in September 2001 for a new wood composites technology that promises to increase the strength of building materials while reducing the cost. The technology allows common adhesives to be used to bond layers of wood with FRP panels. The new process provides a simple, inexpensive, viable means for

reinforcing structural wood products such as beams, I-joists, or flat panels. This technology increases the strength, stiffness, and ductility of wood composites and allows for longer spans, lower depths, and lighter structures. The products developed can potentially replace concrete and steel using low-grade wood and wood by-products.

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### **Coatings, Chemicals, and Ingredient Materials**

#### **New Wood Preservative Method**

A new method for treating wood, developed by CSIRO Forestry & Forest Products of Australia, employs "super-critical" carbon dioxide to spread preservative throughout the wood. It was found that this CO<sub>2</sub> method gives much better preservative retention than conventional techniques. This new process is found to work even better on the current generation of MDF and engineered lumber products such as LVL. The capital cost of treatment facilities is greater than those for conventional processes, however the operational cost is much less according to CSIRO researchers.

Current research is focused on the use of supercritical fluid to spread termite

and fungus resistant preservatives through the fine structure of wood. There are now drying requirements or holding of the stock as with solvent-based techniques. The process also eliminates problems associated with solvent residue found with current techniques.

Prime uses or applications for this new method include window and house frames, LVL, decking, hardwood flooring, and particleboard.

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### **Heat-Treated Wood**

Heat-treated wood is a new ecological wood product being developed in Finland. It is rot-resistant enough for many outdoor uses, without use of chemicals that harm the environment or peoples health. Heat-treated wood goes through a process, which takes the wood up to 200° C or more, breaking up the sugars in the wood into a form that fungi cannot use. Heat-treated wood also "lives" less, meaning it swells or shrinks less than untreated wood. Drying time is cut to one-third that of traditional chemical means.

The most common species being heat-treated are pine, spruce, birch, and aspen. Uses in place today in Finland include saunas, wooden floors, wall and ceiling panels, doors, windows, furniture, and other decorative applications.

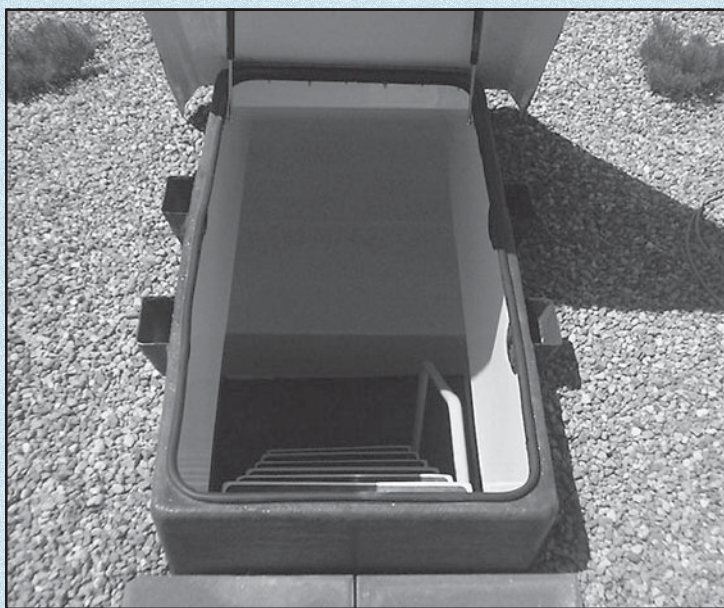
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### **Heat-Sensitive Paint for Climate Control**

Paint that cools your home in the heat of summer and warms it up in the cold of winter has been developed at Tongji University, Shanghai, China. The coating absorbs heat from the sun when temperatures drop below 20° C, helping to warm the building. When the temperature rises above 20° C, the coating automatically starts to reflect sunlight to keep the building cool. The coating increases the temperature four degrees Celsius in the winter and can decrease the temperature about eight degrees Celsius in the summer. The durability of the coating is being improved, as it currently would require

**One-piece  
self-contained  
unit providing  
shelter during  
severe  
storms.**



Courtesy: Southern Illinois Storm Shelter, Inc.



repainting every four years to maintain its effectiveness.

The coating also has the ability to change colors with the seasons, like cooler blues for the summer, and redder tones for the winter.

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**Paint Durability Predictive Testing**

Scientists at University of Missouri at Kansas City have been working on ways to test paint durability even before a brush gets wet. At a conference in Minneapolis, they presented findings that could lead to development of a sensitive, quick durability test for paints and coatings. The process, developed with Brookhaven National Lab, is called positron annihilation. The scientists bombard small painted samples with beams of positrons, or positively charged electrons. When they interact with the molecules in the paint, they send information back to the scientists about the molecules in the paint. They can detect nanometer holes or defects in the paint molecules, which indicate the presence of broken chemical bonds and lead to paint brittleness and premature failure. In addition to being a quick durability test for paints, the knowledge gained will no doubt lead to development of more durable paints.

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**Fireproof Material from Waste Ash**

An amazing fireproof material was developed from waste industrial ash residue. The inorganic ceramic material can withstand extremely high temperatures. The material is non-toxic, does not emit gases in a fire, and is strong enough to withstand cracking from sharp piercing objects. Its current use is insulating steel structure beams, but it could hold promise for applications in insulation panels, decorative tiles, roofing material, etc.

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**Cement that Cures Below Freezing**

Currently the U.S. construction industry spends about \$1 billion per year to provide heated enclosures for placing concrete at below-freezing outdoor temperatures. The current methods have remained relatively unchanged for placing concrete in subzero temperatures since the 1950s. A team of students at Purdue University is developing a new type of cement that cures in below-freezing temperatures. This technology could extend the concrete placing season by several months in the United States and other northern countries. Developed along with the U.S. Army's Cold Regions Research Center, the process shows that concrete can gain strength at subzero temperatures without the need for heat.

Adopting this new low-temperature concrete technology could not only reduce concrete placement cost in the colder months, but save the fossil fuel now being consumed to heat and cure the concrete in the winter months, when that fossil fuel is most needed to heat homes.

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**Innovative Finishing Technology for Wood**

The market for semi-transparent stain and wood protection is growing at faster rate than paint, causing a worldwide demand for high-performance wood finishes. The log home industry is one of the biggest users of semi-transparent finishes because it brings out the natural look of wood. Perma-Chink Systems, Inc., one of the premier finish providers in the log home industry, has brought forth a high performance, water-borne, polymer wood finish called LIFELINE ULTRA-1.

The new generation of high performance finishes protects the wood from damaging UV rays, but allows light to pass through to showcase the natural look of wood. The technology, developed around film thickness, concentration levels, and ultra-fine particle size of pigment, utilizes new transparent iron oxides with greater permanency and transparent clarity. The particle size and shape effectively block UV rays, but allow visible light to pass through, similar to the principles behind metallic coatings on low-e window glass. The polymer technology utilized to support the pigment particles provides the flexibility to allow the film to breathe and move

with the wood's expansion and contraction rates and moisture changes.

In addition, the advanced polymer film is water-borne so it eliminates harmful VOCs and the associated odors, making it more environmentally sound to produce and safer to apply. In the formulation of this new transparent finish are specialized fungus and mold inhibitors as well, for long lasting protection. The finish currently is introduced in seven semi-transparent colors. They have distributors in Colorado, Montana, Minnesota, Tennessee, Washington, and New England. It is priced around \$42/gallon with coverage rates of 300-350 sq ft/gallon.

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***Concrete***

**Cold Weather Concrete**

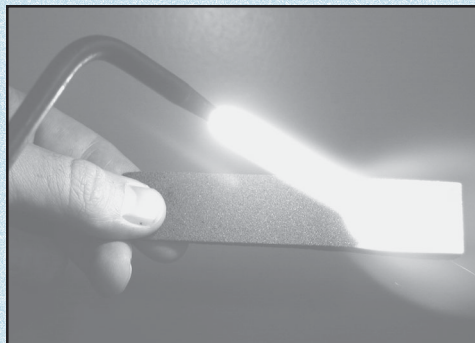
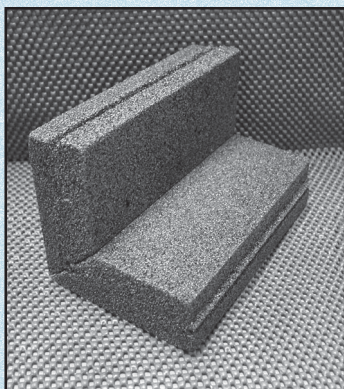
Researchers at the U.S. Army's Cold Regions Research & Engineering Laboratory, along with support from 10 northern states, are developing a new concrete mixture that could significantly extend the construction season.

Currently the US construction industry spends around \$1 billion dollars/year to provide heated enclosures for placing concrete in cold weather. About 80% of that spent of fossil fuels. Adopting this new cold weather concrete could greatly reduce those costs and the amount of fuel used for this purpose. The technology, which centers around the pore structures and freeze/thaw mechanics, produces a lightweight Portland cement concrete mixture that can be placed, consolidated, finished and cured in temperatures below freezing.

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**Carbon foams are a unique, new next-generation structural material. They are inexpensive, lightweight, fire-resistant, impact-absorbing, and can be thermally insulating.**

## Plastics & Foams

### Environmentally-Friendly Plastic Foams

Engineers at Ohio State University have developed dense plastic foam to replace solid plastic applications. Engineers were able to bridge the gap between nanocomposites and foams. Along with the new foam is an innovative manufacturing process that eliminates the use of chlorofluorocarbons (CFCs) in foam production. This new process will meet new international environmental standards that go into effect in 2010. The foam material is lighter weight than the traditional products it would replace. Applications in home building would include foam insulation products, foam packaging material, and potentially insulated skins in composite wall panel applications. The new process works with existing foaming equipment in foam manufacturing plants.

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### Carbon Foams

Carbon foams, being developed by Touchstone Research Laboratory, are a unique, new next-generation structural material. Carbon foam is inexpensive, lightweight, fire-resistant, impact-absorbing, and can be thermally insulating. Its properties are configurable to the desired application. It can be fabricated in a variety of shapes, sizes, and densities. The foam does not off-gas nor does it support ignition. Its properties do not deteriorate with higher temperatures. Carbon foams can be bonded to dissimilar materials. The material is currently in development and final test stages and has application prospects in structural panels and firewalls for automotive, shipping, aircraft, and military. With its property characteristics, it may be a good candidate material for hybrid composite wall panels for houses.

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## Ceramics and Glass

### Glass Coating Kills Bacteria

In development at Northeastern University in Boston, is a surface coating that has been tested on glass to make that surface permanently lethal to several types of bacteria. The coated surfaces kill airborne bacteria microbes. The coating is chemically bonded to the glass so it doesn't wear off when touched or washed. It would have several potential applications from indoor air quality, to killing bacteria on windows, glass mirrors in bathrooms, etc. Other applications being researched include uses on door-knobs (which pass many common cold germs), countertops, and drinking glasses.

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### Self-Cleaning Glass Introduced

Daimon-Fusion International with its new slogan "Innovation that Ignites Business" launched a major breakthrough technology for homes, commercial buildings, and the transportation industry. The biggest news to hit the glass and window industry in years is the introduction of self-cleaning glass by several major glass manufacturers. Some of the producers introducing new glass technology at the NGA 2002 include AFG Industries with Radiance-Ti glass, PPG's SunClean glass product, and a line from Saint-Gobain, while more are planning launches soon.

Self-cleaning glass solves one of the last remaining problems with windows—cleaning them. The hydrophobic coatings manufactured into the glass basically work on reduced surface tension and the contact angles at which particles adhere themselves to the glass. The cleaning process is activated by UV radiation from the sun, which breaks down organic compounds that have accumulated on the glass surface.

Diamon-Fusion's patented coating process creates the ability for the glass to self-clean, in addition to providing a higher scratch- and impact-resistant surface. The process is known also for its cost effectiveness and ease of application. Many window manufacturers will be featuring self-cleaning glass as an option in their window, skylight, and door products. Applications for shower doors, mirrors, and other surfaces are being developed as well.

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